



American Peregrine Falcon Monitoring Protocol for the Central Alaska Network

Protocol Narrative, Version 2.0

Natural Resource Report NPS/CAKN/NRR—2018/1747



ON THE COVER: An American Peregrine Falcon (*Falco peregrinus anatum*) watches over her eyrie during the Central Alaska Network's long-term monitoring program in Yukon-Charley Rivers National Preserve. (NPS/MELANIE FLAMME)

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September 2018

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie, J. H. Schmidt, and S. D. Miller. 2018. American peregrine falcon monitoring protocol for the Central Alaska Network: Protocol narrative, version 2.0. Natural Resource Report NPS/CAKN/NRR—2018/1747. National Park Service, Fort Collins, Colorado.

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Executive Summary

The National Park Service (NPS) has developed a long-term ecological monitoring program known as “Vital Signs Monitoring” to provide the minimum infrastructure and enable more than 270 national park units, organized into 32 networks nationwide, to identify and implement long-term monitoring of their highest-priority indicators of natural resource condition. The Vital Signs Monitoring Program is a major component of the NPS strategy to improve park management through greater reliance on scientific information. This protocol details the justification and procedures for American Peregrine Falcon monitoring, a Vital Sign selected by the Central Alaska Network (CAKN) (MacCluskie and Oakley 2005). The CAKN includes three park units in interior Alaska: Denali National Park and Preserve (DENA), Yukon-Charley Rivers National Preserve (YUCH) and Wrangell-St. Elias National Park and Preserve (WRST) (Figure 1; MacCluskie and Oakley 2005).

The CAKN adopted a holistic view of network ecosystems and tracks the major physical drivers of ecosystem change and responses of the two major components of the biota: plants and animals. Thus, CAKN has identified *Fauna Distribution and Abundance* as one of its top three Vital Signs. The CAKN seeks to learn how fauna are distributed across the landscape and to track changes in both distribution and abundance. The *Fauna Distribution and Abundance* Vital Sign comprises monitoring efforts for a suite of vertebrate species spanning the elevation gradient found in CAKN parks, and also includes species of specific interest within each park.

Raptors, specifically American Peregrine Falcons (peregrines) in YUCH, have been identified as a vital sign within this context because they are top trophic level predators that are indicators of persistent bioaccumulative contaminants in ecosystems. Additionally, CAKN monitors Golden Eagles in DENA and Bald Eagles in WRST. The CAKN scoping workshop (2002) identified these raptors as important vital signs under *Fauna Distribution and Abundance*.

American Peregrine Falcons (peregrines) along the upper Yukon River in YUCH have been monitored almost continuously since the listing of the species under the Endangered Species Act in 1973, after exposure to the contaminant, dichlorodiphenyltrichloroethane (DDT), devastated populations. Additionally, this stretch of the river from the Alaska-Yukon Territory border to Circle, Alaska (Figure 1) was identified as an “index study area” for Alaska in the *Peregrine Falcon Recovery Plan, Alaska Population* (USFWS 1982), and more recently within the *National Monitoring Plan for the American Peregrine Falcon* (USFWS 2003); this index area is located almost entirely within YUCH. A standard monitoring protocol was developed by cooperating agencies; (U.S. Fish and Wildlife Service [USFWS], NPS, Bureau of Land Management, and Alaska Department of Fish and Game) involved in writing the *Peregrine Falcon Recovery Plan, Alaska Population* (USFWS 1982); these protocols have been consistently used within and around YUCH since 1982.

The objectives of CAKN American Peregrine Falcon monitoring project are:

1. To monitor temporal trends in the breeding performance of peregrine falcons along the upper Yukon River from Circle to the Yukon Territory, Canada border. This area includes the entire

stretch of the Yukon running through YUCH. This includes annual measures of territory occupancy, nest success and productivity. Monitoring of breeding performance in YUCH will contribute to an assessment of the status of the continental population which is designed to achieve 80% probability ($\beta = 0.20$) of detecting a decline of 12.5 % over 3 years ($\alpha = 0.10$) (USFWS 2003).

2. To monitor levels of contaminants in eggs and adult peregrine falcons occupying YUCH.
 - a. This includes repeated analyses of eggs for persistent organic pollutants (e.g., DDT and polychlorinated biphenyls (PCBs)), and heavy metals (e.g., mercury and cadmium). Contaminants found in eggs may reflect contaminants exposure on wintering grounds and migration routes.
 - b. To monitor levels of contaminants accumulated in feathers of nestling and adult peregrine falcons on the breeding grounds within YUCH. This includes repeated analyses of feathers for heavy metals (e.g., mercury and cadmium). Contaminants found in nestling feathers may reflect natal area contaminants exposure.

The American Peregrine Falcon monitoring protocol consists of a narrative (this document), Data Quality Standards and Standard Operating Procedures (SOPs) that outline specific aspects of the monitoring protocol. The latest versions of the SOPs and additional supporting information can be accessed online at the NPS Central Alaska Network website:

<https://science.nature.nps.gov/im/units/cakn/> and the Integrated Resource Management Applications portal website: <https://irma.nps.gov/Portal>.
<https://irma.nps.gov/DataStore/Reference/Profile/2218300>

Acknowledgments

A cooperative effort was established between Central Alaska Network (CAKN), Yukon-Charley Rivers National Preserve (YUCH) and U.S. Fish and Wildlife Service (USFWS) to develop the long-term monitoring program for American Peregrine Falcons in YUCH and support the continued recovery of the species. The American Peregrine Falcon monitoring program was launched by CAKN in 2005 (MacCluskie and Oakley 2005).

Funding and support for American Peregrine Falcons monitoring has been provided by CAKN, YUCH, USFWS Environmental Contaminants Program, Student Conservation Association (SCA), Alaska Geographic and Murie Science and Learning Center.

We would like to thank Angela Matz (USFWS) for her multi-year collaboration and support for the surveys and environmental contaminants analyses. We thank David Payer for long-term support and assistance with the surveys and development of analytical methods. Thanks to the YUCH Eagle Visitor Center staff for continued support during the surveys. We are grateful to Randy Smith and Scott Sample (YUCH) and Jack Boyle (Circle, AK) for assistance with boat maintenance, driving and training. We are grateful to the communities of Eagle and Circle, Alaska who have supported the falcon studies for over 40+ years. Members from these communities have shared valuable insights, history and raptor sightings as well as meals and tea with us and we are grateful for your friendship. We thank Regan Sarwas and Jeremy Mizel for the development of the tile package maps on the iPads used for navigation on the Yukon River. Thanks to Sarah Swanson for informal review and editing of this protocol. Many thanks to Sean Tevebaugh, Dev Dharm Khalsa and Josh Spice for fantastic photography and videos of falcons and field work on the river. We are grateful to the scores of dedicated and hard-working student and adult volunteers (VIPs), undergraduates, graduate students, STEP, SCA interns, YCCs, park biologists and biological technicians who have assisted with field work over these 40+ years. In particular, we thank Julia Brice, Anna Quist, Sarah Swanson, Patrick Knavel, Tristan Schoemaker, Cadence Chinley, Josh Spice and Delaney Vinson-the Falcon Dream Team! Lastly, we are grateful to John “Johnny” Burch, retired wolf biologist for YUCH, who assisted on the surveys for many years, always fixed the boat, navigated like a pro and taught us all so much.

List of Key Acronyms

ANILCA	Alaska National Interest Lands Conservation Act
CAKN	Central Alaska Network
CV	Coefficient of Variation
DDT	Dichlorodiphenyltrichloroethane
DENA	Denali National Park and Preserve
DQS	Data Quality Standard
I&M	Inventory and Monitoring Program, NPS
IRMA	Integrated Resource Management Applications Data Store
NPS	National Park Service
NRR	Natural Resources Report
PEFA	American Peregrine Falcon (<i>Falco peregrinus anatum</i>)
QA/QC	Quality Assurance and Quality Control of survey data
SOP	Standard Operating Procedure
USFWS	U.S. Fish and Wildlife Service
WRST	Wrangell-St. Elias National Park and Preserve
YUCH	Yukon-Charley Rivers National Preserve

Introduction and Objective

Background and History

Knowing the condition of natural resources in national parks is fundamental to the National Park Service (NPS) mission to manage park resources "unimpaired for the enjoyment of future generations." Park managers are confronted with increasingly complex and challenging issues that require broad-based understanding of the status and trends of park resources as a basis for making management decisions and working with other agencies and the public for the long-term protection of park ecosystems. The purpose of natural resource monitoring in parks is to collect scientifically sound information regarding the current status and long-term trends in the composition, structure, and function of park ecosystems, and to determine how well current management practices are sustaining those ecosystems (Fancy *et al.* 2009). Use of monitoring information will improve the ability of park managers to make science-based decisions and address legal and political issues involving parks and park resources for more effective park operations and management. The overarching goals of the NPS monitoring program are to:

1. Determine the status and trends of selected indicators of park ecosystem conditions to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources;
2. Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management;
3. Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments;
4. Provide data to meet certain legal and Congressional mandates related to natural resource protection and visitor enjoyment; and
5. Provide a means of measuring progress towards performance goals.

This protocol outlines the justification and procedures for American Peregrine Falcon (peregrine) monitoring within the Central Alaska Network (CAKN). The CAKN includes three interior Alaska parks: Denali National Park and Preserve (DENA), Yukon-Charley Rivers National Preserve (YUCH) and Wrangell-St. Elias National Park and Preserve (WRST), which collectively represent 21.7 million acres (MacCluskie and Oakley 2005).

The peregrine population breeding within the upper Yukon River valley is believed to be one of the best and longest studied populations in North America. Over 40 years of data document the population's recovery from 11 pairs in 1973 (Ritchie 1976) to 50-60 pairs in 2015 (Ambrose *et al.* 2016). The U.S. Fish and Wildlife Service (USFWS) tracked the recovery of the YUCH and other continental populations after the contaminant, dichlorodiphenyltrichloroethane (DDT), was banned. The study was supported by staff from USFWS Service and NPS at YUCH since the early 1980s and has continued almost annually since its inception. The number of total pairs nesting along the upper Yukon River has been steadily increasing, although the percentage of total pairs nesting successfully has been declining. This may be attributable to increased competition for resources due to increased

density. Further monitoring is necessary to understand the natural variation of a “healthy” American Peregrine Falcon population, which will allow detection of population change that is beyond normal limits of variation.

The stretch of the river from the Alaska-Yukon Territory border to Circle, Alaska (Figure 1) was identified as an “index study area” for Alaska in the *Peregrine Falcon Recovery Plan, Alaska Population* (USFWS 1982), and more recently within the *National Monitoring Plan for the American Peregrine Falcon* (USFWS 2003); this index area is located almost entirely within YUCH. A standard monitoring protocol was developed by the cooperating agencies (USFWS, NPS, Bureau of Land Management, and Alaska Department of Fish and Game) involved in writing the *Peregrine Falcon Recovery Plan, Alaska Population* (1982); these protocols have been consistently used within and around YUCH since 1982. In 2005, the administration and implementation of American Peregrine Falcon monitoring program in YUCH was assumed as part of CAKN’s “Vital Signs” Inventory and Monitoring Program (MacCluskie and Oakley 2005).

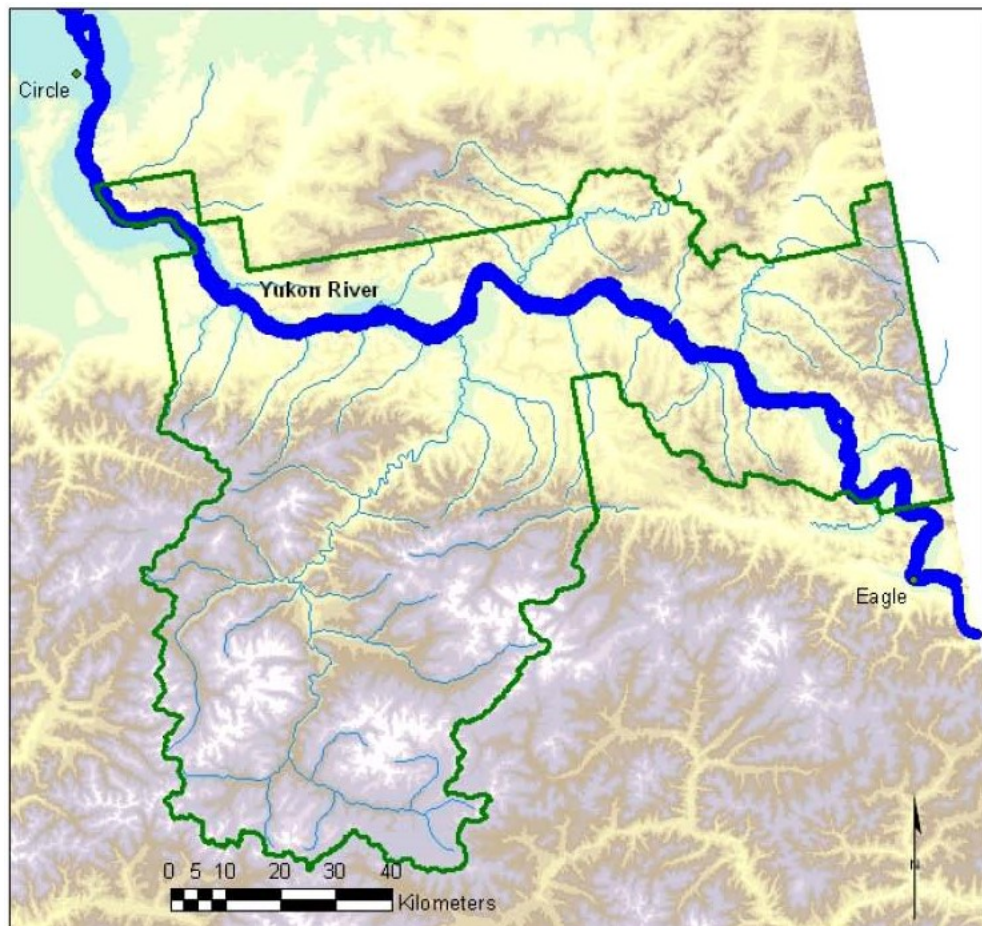


Figure 1. The Upper Yukon study area includes all available habitat within 1 km of either bank of the upper Yukon River between Circle, Alaska and the Yukon Territory border. The area was also designated as a “Yukon River Peregrine Falcon Index Area” under the *Monitoring Plan for the American Peregrine Falcon* (2003). Yukon-Charley Rivers National Preserve, Alaska, is outlined in green.

Rational for American Peregrine Falcon Monitoring

The ability to detect and track resource changes over time and to understand the forces driving those changes are fundamental to accomplishing the NPS's mission of conserving parks unimpaired for future generations. The CAKN developed its monitoring program to encompass several trophic levels of park ecosystems so that the program would be as robust as possible to detecting change wherever it might occur (MacCluskie and Oakley 2005). The CAKN scoping workshop (2002) identified raptors as important vital signs under *Fauna Distribution and Abundance*. American Peregrine Falcons (*Falco peregrinus anatum*) occurring along the upper Yukon River corridor, within and adjacent to YUCH, were selected by the National Park Service (NPS) as an important CAKN vital sign. *Fauna Distribution and Abundance* was identified as one of CAKN's highest priority vital signs. American Peregrine Falcons (peregrines) were specifically identified because they are long-lived, top trophic level predators that are indicators of persistent bioaccumulative contaminants (Ambrose *et al.* 2000; MacCluskie and Oakley 2005). Additionally, CAKN monitors other raptors, including Golden Eagles in DENA and Bald Eagles in WRST.

American Peregrine Falcons are medium-sized raptors that prey almost entirely on birds. Their breeding range extends from Mexico north to the tree-line in Canada and Alaska. In Alaska, they occur in the forested interior, nesting primarily on cliffs along the major rivers. In the northern parts of its range, the American Peregrine Falcon is highly migratory, wintering as far south as Brazil and Argentina. The upper Yukon River, from the Alaska – Yukon Territory border to Circle, Alaska, provides excellent cliff-nesting habitat for peregrines as well as an abundant variety of prey species. The majority of this habitat lies within YUCH, with peregrine protection being one of the primary reasons for the Preserve's establishment in 1980 (U.S. Congress). The enabling legislation establishing YUCH, the Alaska National Interest Lands Conservation Act (U.S. Congress 1980), states:

“the preserve shall be managed for the following purposes... to protect habitat for, and populations of, fish and wildlife, including but not limited to peregrine falcons and other raptorial birds, ...”

Beginning in the late 1940s, the use of persistent organochlorine pesticides greatly affected peregrines in North America. These pesticides affected mortality and behavior, and caused birds to lay thin-shelled eggs that often failed to hatch (crushed during incubation) and consequently lowered productivity. Peregrines were classified as endangered in 1973 under the Endangered Species Act (U.S. Congress). In interior Alaska, peregrines declined to approximately 20 percent of historical levels by the mid-1970s. In 1972, the United States restricted the use of persistent organochlorine pesticides, and since 1978, American Peregrine Falcons in interior Alaska have been increasing.

Recovery efforts, including the banning of DDT, as well as captive breeding and release, resulted in its formal delisting of the species in 1999 (Mesta 1999). Contaminants analyses of peregrine eggs from YUCH suggest that mercury, a persistent compound which bio-accumulates at high trophic levels causing toxic effects (similar to DDT), is approaching levels that may affect reproduction and trends suggest that mercury levels may be increasing (Ambrose *et al.* 2000). High levels of mercury may occur naturally in the study area. In addition, mercury can be made biologically available through industrial processes such as mining and waste incineration and will likely increase with

global industrialization. Also, DDT and other pesticides are still being used in wintering grounds, which may cause continued risk to migratory bird populations. Continued monitoring of contaminants concentrations in peregrine egg shells and nestling and adult feathers allow tracking of these toxic compounds at wintering grounds, along migration routes, and at breeding grounds.

One important aspect of the peregrine population in YUCH is that this population has recovered naturally without interventions from humans. Nest manipulations, captive breeding, releases, and legal “take” have never occurred there. In all other populations in the lower-48 states, there have been influences of these manipulations and captive-breed releases. Hence, the upper Yukon River population is unique for this subspecies as one where the recovery has been completely natural and well-studied.

The peregrine falcon population breeding within YUCH is believed to be one of the densest populations in North America, and the 40+ year dataset is one of the longest and most completely recorded. The peregrine population within YUCH was selected as one of two index study areas for Alaska in the *Peregrine Falcon Recovery Plan, Alaska Population* (USFWS 1982), and more recently in the *National Monitoring Plan for the American Peregrine Falcon* (USFWS 2003).

Though peregrines are still accumulating contaminants, levels are currently low enough for reproduction and subsequent population expansion. Continued monitoring of the increasing peregrine population in YUCH provides a unique opportunity to contribute data about the recovery and response of a natural population to increased densities. It is critical that the NPS in Alaska takes a leading role in providing such baseline information given the selection of the YUCH study area as an important index area for the state and nation, and our unique NPS mission to manage for intact ecosystems. It is also important to have multiple parameter measurements of a population because various stressors will manifest differently. For example, as the population grows and density increases for a given area, productivity may decline; or high levels of mercury contamination may elicit a rapid decline in adult survivorship.

Due to their near extinction, and subsequent recovery and delisting (USFWS 1999) following the ban of DDT throughout their breeding range, peregrines have become a public symbol for recovery and conservation, and specifically for YUCH. Nesting peregrines are one of the top visitor attractions in YUCH and there is strong public support for their protection and the monitoring program. Through the love and interest in peregrine falcons, YUCH and CAKN gain support to protect the entire ecosystem to which they belong. It is important to continue to garner support by sharing the recovery (USFWS 1999) and success story of the American Peregrine Falcons’ natural recovery to further their conservation.

National American Peregrine Falcon Monitoring Plan

The CAKN protocol provides data required by the national USFWS Plan (2003) for the YUCH study area, and more detailed information on peregrine falcons in YUCH. It significantly expands survey objectives from those in the USFWS Plan (2003) and continues to use survey protocols developed and used historically in Alaska.

Section 4(g)(1) of the Endangered Species Act requires a post-delisting monitoring period of at least 5 years for species removed from the list as specified in the Monitoring *Plan for the American Peregrine Falcon* (USFWS 2003, hereafter, the USFWS Plan). The USFWS Plan (2003) outlines a long-term monitoring strategy that extends beyond the 5-year period. The USFWS Plan (2003) requires, in most regions, monitoring of a randomly selected subsample of territories every three years. For the Alaska region, the USFWS Plan (2003) calls for monitoring the two index study areas (Yukon and Tanana Rivers) every three years. Regional results are used to infer nation-wide trends and to compare against criteria identified in the USFWS Plan (2003). The primary objective of the USFWS Plan (2003) is to detect changes in three parameters: territory occupancy, nest success, and productivity. Contaminants monitoring is included in the USFWS Plan (2003), and YUCH is one of the units selected for contaminants monitoring.

Both index study areas identified in the *Alaska Peregrine Falcon Recovery Plan* (USFWS 1982, hereafter, Alaska Plan), the upper Yukon (contained almost entirely within YUCH) and upper Tanana Rivers, were selected for population monitoring by the USFWS Plan (2003). There are currently 45 to 50 occupied territories in each of these study areas. The USFWS Plan (2003) for monitoring territory occupancy, nest success, and productivity in Alaska is consistent with past monitoring efforts of the species as identified in the Alaska Plan (USFWS 1982) with two exceptions. First, the USFWS Plan (2003) departs from standard protocol in terms of the age at which nestlings are counted in determining nest productivity. The USFWS Plan (2003) specifies counting nestlings at 28 days, whereas standard raptor monitoring protocol counts nestlings at 80% of fledging age (34 days) (Pendleton *et al.* 1987). Second, the USFWS Plan (2003) requires monitoring selected nests every three years for 15 years. Past survey efforts in Alaska have conducted annual surveys as recommended in the Alaska Plan (USFWS 1982). Long-term monitoring under CAKN will occur annually in perpetuity (MacCluskie and Oakley 2005).

The USFWS Plan (2003) encourages continued monitoring of peregrine falcons in Alaska in between years of the official triennial sample. The CAKN monitoring protocol herein collects more detailed data annually in YUCH than specified by the USFWS Plan (2003). Annual versus triennial monitoring allows more rapid detection of population changes. Historical data from the Colville River in northern Alaska show that local populations can decline by more than 75 percent in a 3-year period (Ambrose *et al.* 1988). It is essential that surveys be frequent enough to ensure that such declines are detected as soon as possible.

Objectives

The objectives of CAKN American Peregrine Falcon monitoring project are:

1. To monitor temporal trends in the breeding performance of peregrine falcons along the upper Yukon River from Circle to the Yukon Territory, Canada border. This area includes the entire stretch of the Yukon running through YUCH. This includes annual measures of territory occupancy, nest success and productivity. Monitoring of breeding performance in YUCH will contribute to an assessment of the status of the continental population which is designed to achieve 80% probability ($\beta = 0.20$) of detecting a decline of 12.5 % over 3 years ($\alpha = 0.10$) (USFWS 2003).

2. To monitor levels of contaminants in eggs and adult peregrine falcons occupying YUCH.
 - a. This includes repeated analyses of eggs for persistent organic pollutants (e.g., DDT and polychlorinated biphenyls (PCBs)), and heavy metals (e.g., mercury and cadmium). Contaminants found in eggs may reflect contaminants exposure on wintering grounds and migration routes.
 - b. To monitor levels of contaminants accumulated in feathers of nestling and adult peregrine falcons on the breeding grounds within YUCH. This includes repeated analyses of feathers for heavy metals (e.g., mercury and cadmium). Contaminants found in nestling feathers may reflect natal area contaminants exposure.

Methods

Survey methods were derived from the Alaska Plan (USFWS 1982) and USFWS Plan (2003). Additionally, methods were developed specifically for the population in YUCH by CAKN (herein). In 2005, peregrine monitoring was incorporated under the new CAKN Vital Signs monitoring program (MacCluskie and Oakley 2005). The CAKN American Peregrine Falcon protocol herein was designed 1) to align with USFWS post-delisting monitoring requirements 2) to increase survey efficiency and feasibility and 3) to update and improve field data collection and 4) to use new field and analytical methods to improve estimates (Ambrose *et al.* 2016).

Modifications of CAKN methods include:

1. CAKN American Peregrine monitoring utilizes larger field-crew sizes (2-4) to improve peregrine detections. Bluffs can be watched almost continuously as crew members take turns watching for birds while others set up camp, prepare meals, or drive the boat between sites. Crews can be divided into teams to watch two bluffs at once. Effort is increased because more scopes and binoculars are scanning large bluffs for birds simultaneously.
2. CAKN American Peregrine monitoring deviates from the USFWS Plan (2003) by counting chicks in early-late July, when nestlings range from 15-30 days old (nestlings older than 30 days may be prone to jump when the nest is entered). This timeframe was selected because nestlings at different sites along the river may begin to fledge and leave the nest in late July or August.
3. CAKN American Peregrine monitoring deviates from the USFWS Plan (2003) by conducting surveys annually rather than triennially. Annual monitoring meets objectives of both the USFWS Plan (2003) and CAKN protocol, and provides more detailed trend information about the natural recovery of YUCH peregrine populations. Annual monitoring also provides earlier warning of population changes in the event of adverse impacts, e.g., from contaminants or disturbances.
4. CAKN American Peregrine monitoring utilizes both paper nest cards (USFWS 1999) in the field and an Access database that matches the nest card fields (developed by CAKN) to which annual data are appended.
5. CAKN American Peregrine monitoring surveys all historic nesting territories within the study “index” area (length of river) rather than subsamples of territories. Further, newly established territories in the index area are actively searched for and incorporated into the monitoring.
6. CAKN Peregrine monitoring has updated analytical methods to estimate territory occupancy, nest success and productivity. Data analysis procedures are described in detail in SOP 10 and Ambrose *et al.* 2016. CAKN Peregrine monitoring data analysis employs two statistical approaches:
 - a. The first analyzes all data aggregated across territories for all years of observations from different observers. This allows the comparison of annual observations from earlier data sets (Cade *et al.* 1968, 1971, 1976; Enderson *et al.* 1968; Temple *et al.* 1970; Ritchie 1976) based on summary statistics of data aggregated across territories

for each year. A Poisson regression, with robust standard errors for the number of occupied territories each year regressed on year, is used because the dependent variable (number of occupied territories) is a count variable. Nearest-neighbor Distance are regressed on year using Prais–Winsten regression to correct for autocorrelation (Wooldridge 2008). Productivity data and reproductive metrics are analyzed using polynomial regression. The SigmaStat 3.10 Incremental Evaluation tool is used to determine the appropriate order polynomials to use, and then a regression is run using the appropriate polynomials to obtain the final results (Systat Software, Point Richmond, CA). The Kolmogorov–Smirnov is used to check normality, the Spearman’s rank test checks for constant variance, and the Durbin–Watson test checks for serial correlation (α 0.05 for all tests).

- b. The second approach uses mixed models for the period of 1977 onward and territories as the unit of analysis. The data consists of a time series of observations at each nesting territory. A mixed model approach with yearly observations contained within territories is used, which allows the consideration of each observation at each nesting territory across all years the territory was occupied.

Site Selection

The study area is located on a section of the Yukon River between the Alaska – Yukon Territory border (64° N, 141° W) and Circle, Alaska (65° N, 144° W), a distance of 265 km (165 miles). The study area is limited to 1 km on either side banks of the main stem Yukon River (Figure 1). The river elevation varies from 260 m (865 ft) above sea level at the Alaska – Yukon Territory border to 170 m (560 ft) at Circle, Alaska. Cliffs, rock outcrops, and dirt banks are common along the river, ranging from 8 m to 600 m above the river. The area’s diverse topography, frequent wildfires, discontinuous permafrost, and climate interact to create a complex mosaic of taiga and tundra within the subarctic boreal forest zone (NPS 1993). Spruce/hardwood forest, wet meadows, tussock tundra, shrub thickets, and sparsely vegetated gravel bars dominate. Black spruce (*Picea mariana*) forest occurs in poorly drained areas on north-facing slopes, low terraces and floodplains. White spruce (*P. glauca*), paper birch (*Betula papyrifera*), quaking aspen (*Populus tremuloides*), and/or balsam poplar (*P. balsamifera*) are common at well-drained sites along riparian areas, steep drainages, and south-facing slopes.

Most of the vegetation is a mosaic of communities influenced by regular fires. Gallant *et al.* (1995) provides a more detailed description of the study area, a combination of the Interior Forested Lowlands and Uplands Ecoregion at the upriver end of the study area to the Yukon Flats Ecoregion at the downriver end.

The study area overlaps the index area specified in the *Alaska Peregrine Falcon Recovery Plan* (USFWS 1982). The area includes the upper Yukon River in and near YUCH (Figure 1). Surveys are not limited to known nesting territories; rather, we attempt to survey additional potential nesting territories in the study. This method incorporates an element of inventory into the monitoring plan in that investigators will search all suitable habitat along the length of the river searching for evidence of occupancy by peregrine falcons.

Sampling Design

The CAKN survey protocol will follow those generally used in prior Alaska surveys, which focus on index study areas rather than looking only at territories known to have been used in the past (as recommended for other regions in the USFWS Plan). Index study areas in interior Alaska included a specific section of river (upper Yukon or upper Tanana rivers). We attempt to survey all known and additional, potential new nesting territories in the study area within 1.0 km of either bank of the upper Yukon River between Circle, Alaska and the Yukon Territory border

The approach of surveying index areas rather than specific territories in CAKN units is favored by NPS for several reasons. By completely re-surveying an established study area annually, new territories will be discovered and this will provide information about the continuing (or lack of) recovery of peregrine falcons (although the species was delisted in 1999, the species was not fully recovered but rather no longer in danger of extinction). Thorough surveys of index study areas do not have this bias in that all potential territories, both good and bad, are surveyed annually. This is important because low quality, seldom-used territories are the ones most likely to be vacated as a result of population decline, thus changes in population parameters may be detected sooner when surveying a given area rather than only known territories. Additionally, pairs which move to a new cliff will more likely be found by a complete survey of a study area than by visits to a historically-used location, thus improving estimates of percent occupancy. Finally, since researchers are able to spend more time in one study area (rather than traveling to several widely dispersed nest territories), they are able to collect more detailed information on the local population in the index area. This sampling design also allows for direct comparisons with the previous monitoring data collected annually for 40+ years, and has proven to be monetarily and operationally efficient.

In addition to the valuable information gained by monitoring peregrine falcons within a fixed study area, it is likely that these index areas are consistent with trends observed across interior Alaska. Using “index areas” as representative of a larger area or larger local population was proposed in the *Alaska Peregrine Falcon Recovery Plan* (USFWS 1982) and has proven effective in Alaska based on analysis of 10 to 15 years of survey data for six rivers in interior Alaska (Payer 2001). Survey data from either of the two index rivers selected (the upper Yukon and upper Tanana rivers) were shown to accurately represent survey data from all of the other rivers. Hence, for this species, the use of index areas to represent a larger area is a viable survey approach which helps to reduce overall survey effort and travel costs.

Monitoring Schedule and Sampling Frequency

The CAKN American Peregrine Falcon Monitoring occurs annually in perpetuity. Peregrine surveys in YUCH have occurred nearly annually from 1973-2016. Occupancy surveys to identify nesting territories occur from mid-May to early June as soon as the ice melts and the river is accessible (approximately three weeks). Timing of the occupancy survey is dictated by the date of ice breakup on the Yukon River, which generally occurred by mid-May. Peregrine Falcons in this area have usually completed their clutches by this date. Productivity surveys to count nestlings occur after hatch but before fledging from early-late July (approximately three weeks) (Table 1).

Table 1. Annual field survey schedule for American Peregrine Falcon monitoring in YUCH.

Survey Type	May	June	July
Occupancy*	X	X	–
Productivity**	–	–	X

* ~May 20-June 10

**~July 6-26

Field Methods

Before beginning the field season, observers review this entire protocol, including all of the SOPs, Alaska Plan (USFWS 1982), USFWS Plan (2003, Appendix A), and Colorado Division of Wildlife Field Protocol (see Appendix 4 of Craig and Enderson 2004). Preparation and training for observers is described in SOP 1 “Before the Field Season” and SOP 2 “Training Observers.” Equipment and supplies listed in SOP 1 are organized and made ready for the field season, and copies of the Alaska Raptor Nest Card (nest cards) (USFWS 1989) in SOP 5 “Conducting the Peregrine Falcon Survey” are printed (on acid-free, water-proof paper).

General sampling times and logistics are organized prior to the start of each field season. However, flexibility is required in scheduling sampling trips because of unpredictable weather and break up (river thaw).

Surveys involve two visits to potential habitat or known territories during the breeding season to ascertain territory status (occupancy) and determine productivity of active nests. Potential territories include cliffs >350 m to steep dirt banks <5 m. Each visit may require up to four hours of observation to determine status of the territory. In most cases, activity such as a nest exchange, feeding, hunting, or flight will occur during a four-hour period. No loud, explosive devices shall be used to flush birds from nests or perches; recorded vocalizations may be used to elicit responses from territorial birds. Surveys are conducted in ambient weather and delayed to wait out extreme weather events so that consistent survey data can be obtained. Peregrines may hunker down in extreme weather such as high winds, heavy rain, thunderstorms or snow, which may hamper efforts to boat along the river and impede detectability of birds.

Peregrine falcon surveys are conducted with two to four observers. Each observer is assigned to watch a different bird or eyrie site to increase detection efforts. All observers shall review appropriate literature on peregrine falcons, their behavior during the nesting season, and survey techniques.

Field notes and data forms are used during each visit to record falcon activity, which results in a season summary of the status of the territory. In addition, photographs or sketches of the nest ledge are collected, coordinates of the territory are determined, and maps are used to mark the location of important features of the site. Refer to SOP 5, “Conducting the Peregrine Falcon Survey” for detailed instructions on conducting the survey.

Surveys are conducted using a 21-ft motorized river boat launched from Circle. The crew travels upriver from Circle to the Alaska – Yukon Territory, Canada border, and back again. During the occupancy survey (late May to early June), all potential nesting territories along the river are observed from shoreline or islands using binoculars and spotting scopes. Observations are conducted for up to four hours at each potential nesting territory (historic or potential), unless occupancy is determined sooner. When possible, campsites are chosen for their proximity to potential nesting territories to extend observation periods. The productivity survey (early to late July) is conducted similarly, all occupied territories are observed using binoculars and spotting scopes to determine the number and age of nestlings if possible. Additionally, eyries that are difficult to see from shore may be entered using standard rock climbing techniques to confirm the number of young. Samples such as prey remains, unhatched (addled) eggs, and nestling and adult feather may be collected for contaminants and other analyses.

Nestlings ages is estimated by comparison to photographs of known-age nestling prairie falcons (*Falco mexicanus*) (Moritsch 1983) and nestling peregrine falcons (Cade *et al.* 1996). The age of the oldest nestling is used for all chicks in each nest.

Nesting territories are noted on U.S. Geological Survey topographic maps (1:63,360) and latitude and longitude from GPS units and iPads with the Park Observer application are used for navigation and to mark waypoints of all territories. Nest-occupancy data and nest-site characteristics are entered into the Alaska Raptor Observation Cards (nest cards) (USFWS 1989).

Narrative descriptions of behavior, nest site locations and other observations are kept in field notebooks. Terminology and definitions follow those described in the National Wildlife Federation's Raptor Management Techniques Manual (1986). The following data are collected:

1. Number of nesting territories occupied by a pair;
2. Number of nesting territories occupied by a single adult;
3. Number of pairs attempting to breed;
4. Number of pairs with nestlings;
5. Number of nestlings reaching 2 to 4 weeks of age; and
6. Estimated Age of nestlings at time of nest visit.

Nesting phenology is calculated based on 7 days for clutch completion, 33 days for incubation (with incubation beginning after the third egg, 6 days after the first egg was laid), and 40 days from hatching to first flight (Cade *et al.* 1996). Ages of nestlings are estimated during nest visits using photographs of known-age nestlings (Cade *et al.* 1996).

The following nest site information is collected for each new occupied eyrie and/or territory (previously used sites are documented in past years):

1. Estimated cliff height (primary rock surface area, m);
2. Estimated cliff height above river (talus slope or forested area below cliff, m);
3. Estimated cliff length (km);

4. Estimated nest height on cliff (relative to rock surface area, m); and
5. Estimated nest height above river (m).

During the productivity survey, the number of successful pairs and the number of nestlings at successful nests are determined. Nestlings are most often counted from the shore using spotting scopes but are also counted by climbing above or into the nest.

Terminology follows Steenhoff (1987) with slight modifications for productivity and successful breeding:

- Fledged Young: For survey purposes, young falcons that could fly or had reached 80% or more of their respective fledging age (32 days old for peregrine falcons) are considered fledged.
- Nest Site: The actual site of the nest (or scrape) on the cliff. More than one nest site may be present within the nesting territory of a pair of birds.
- Nesting Territory: An area that contains, or historically contained, one or more nest sites within the breeding territory of a pair of peregrines, and where no more than one pair has ever bred in any one year. The size of nest territories can change as the population size changes. For example, in a depressed population, one pair may use a large nest territory which includes several nest sites. However, if the population expands and a second pair moves into this “territory,” the size of the original nest territory contracts and the larger area becomes two separate nest territories.
- Nestling: Young of the year between hatching and fledging.
- Occupied Nesting Territory: A nesting territory where one or two birds show an affinity for the territory and defend the territory against other falcons.
- Productivity: Reproductive output, measured as the number of nestlings raised by a pair. This is expressed both as number of nestlings per total pair and number of nestlings per successful pair. It is important to note that these values are not the number of young fledged, but the number of nestlings generally 10-30 days old.
- Successful breeding: Having one or more nestling.

Nest territory occupancy is defined as regular (occupied 80 percent or more for all years), irregular (occupied 20 to 80 percent of all years), and occasional (occupied less than 20 percent of all years).

Alaska Raptor Observation Record Card (front) and Alaska Raptor Eyrie Record Card (back) (USFWS 1989) are both printed on opposite sides of the same “nest card.” All nest card data are entered into the CAKN Peregrine Access database (CAKN_PEFA.accdb). The database has fields that match the revised Alaska Raptor Observation/Eyrie Record Card. All digital historical data (including Access database, photos, nest cards, field notes, maps of territories and eyries information) are scanned and archived on the CAKN network drive and in the IRMA Data Store:

<https://irma.nps.gov/DataStore/Reference/Profile/2218300>.

Data Management

Data management for the Peregrine Falcon monitoring program will proceed through an ongoing life cycle as shown in Figure 2. (NPS 2008a). Major stages of the life cycle include data collection, data entry and import, quality control, data product documentation and archival, seasonal closeout, dataset certification, and data analysis and reporting (NPS 2008b).

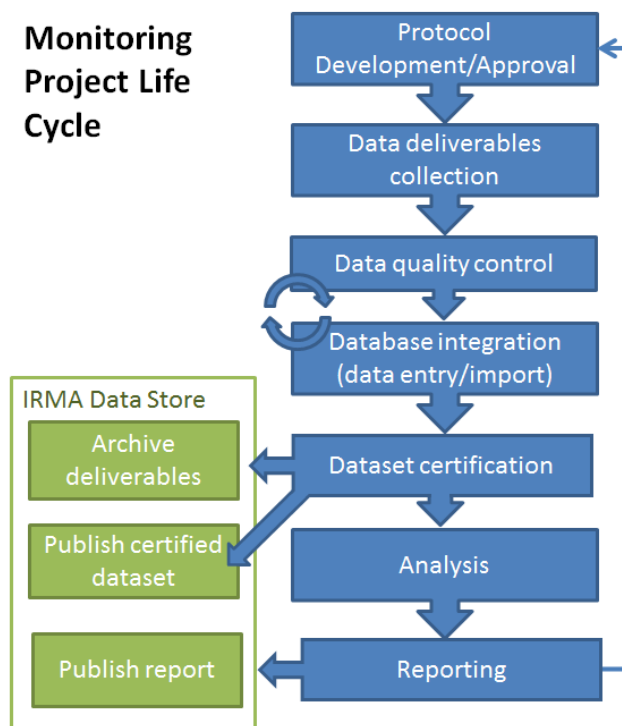


Figure 2. Long term monitoring project data management life cycle.

An overview of each component of the Peregrine Falcon monitoring data management life cycle follows. Specific procedures are given in standard operating procedures.

NPS Standards

Data Quality

Director's Order #11B (NPS 2005b) mandates a high level of information quality from the service's scientific programs:

"The National Park Service will ensure that information it releases will be developed from reliable data sources and will otherwise ensure information quality at each stage of information development. The NPS's methods for producing quality information will be made transparent, to the maximum extent practicable, through accurate documentation, use of appropriate internal and external review procedures, consultation with experts and users, and verification of the quality of the

information disseminated to the public. The NPS will also keep users informed about corrections and revisions.

Information will be developed only from reliable data sources based on accepted practices and policies utilizing accepted methods for information collection and verification. It will be reproducible to the extent possible. Influential information will be produced with a high degree of transparency about data and methods. The information should include all pertinent information to allow the public to understand the park's legislative authorities, mission, activities, organization, strategic plan, performance plan, and performance accomplishments.”

Director’s Order #11A section 5.8: Data Integrity Standards (NPS 2005a) outlines the NPS policy for accuracy, completeness and review:

“All information owners will maintain all official NPS records and data in a manner which meets the highest data integrity standards, including timeliness, accuracy and completeness (also see DO #11D). Each information owner will take whatever steps necessary to ensure that NPS systems have sufficient data quality reviews and audits from both an internal system perspective, as well as externally thorough control reviews.”

Adherence to the data management procedures in this monitoring protocol will ensure compliance with Director’s Order 11 (DO#11).

Freedom of Information Act

The Network will comply with all FOIA restrictions regarding the release of data and information as instructed in NPS Director’s Order #66B (NPS 2005c).

Records Management

Direction for managing physical and digital materials is provided in NPS Director’s Order 11D (NPS 2012).

“The NPS has a strong business need for excellent records management, in that the Service’s mission is to care for natural and cultural resources so that they are left “unimpaired” for future generations. This requirement for managing resources in perpetuity sets a high standard for record keeping. No resources can be managed well in the future without complete records of how they were managed in the past. Because the NPS manages some of America’s most significant cultural and natural resources, the public also has a significant interest in our records. Section 1.9.2 of NPS Management Policies 2006 (NPS 2006) states that the future of the Service depends on the availability, management, dissemination, and preservation of information, and directs the agency to implement professional quality programs to manage information resources.”

Core Functional Model

Data generated by the CAKN Peregrine Falcon monitoring program are managed according to the Core Functional Model described in Figure 3.

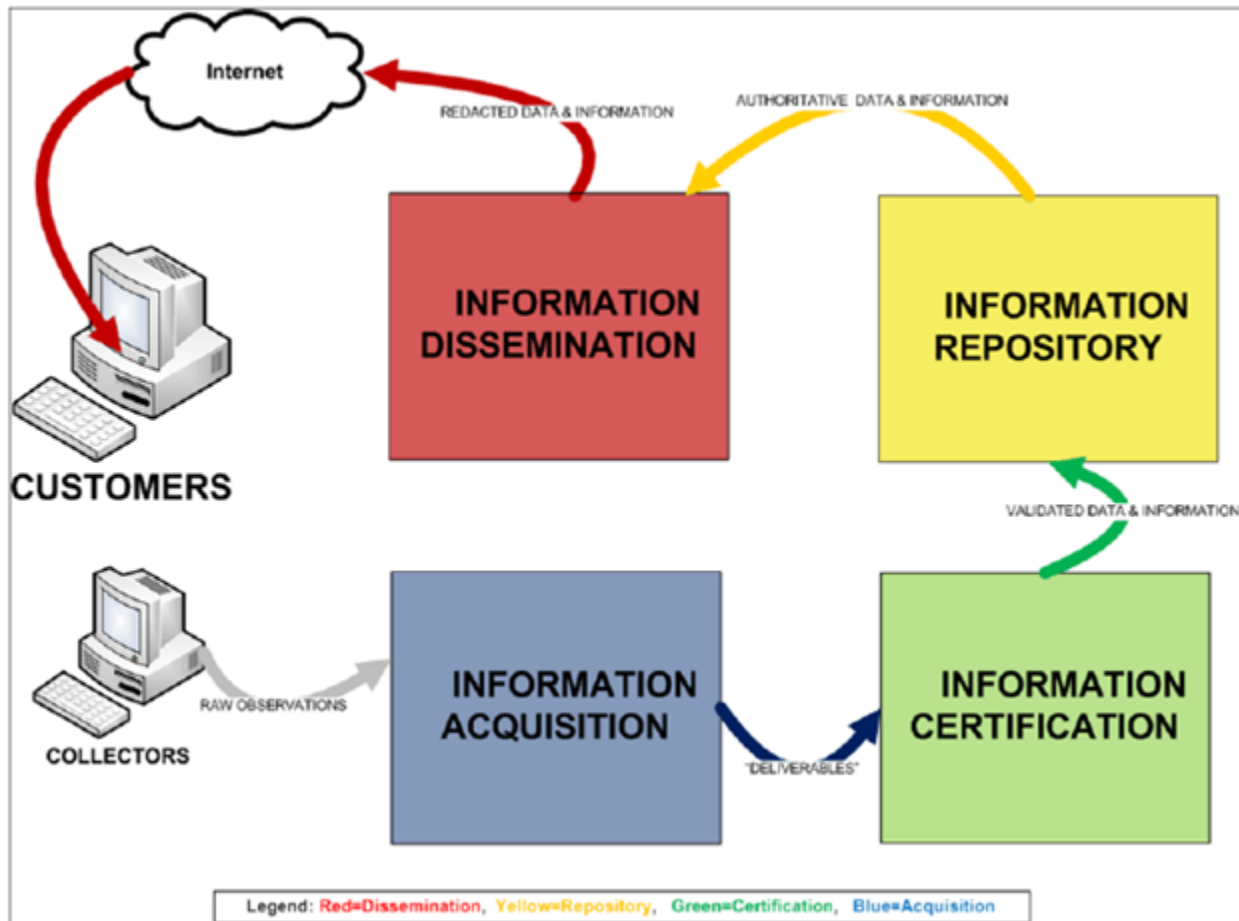


Figure 3. The CAKN Core Functional Model overview.

Dissemination services (red, **Error! Reference source not found.**3) provide all deliverables to all customers using internet web sites and web services through the NPS Integrated Resource Management Applications (IRMA) Data Store. Repositories (yellow) store the certified inventory and monitoring products called for in the protocols. Certification processes (green) assure repositories have the highest quality data and that sensitive items are restricted to authorized users. Data acquisition processes (blue) led by park staff and cooperators include a wide array of tasks, ranging from collecting raw data to composing reports on long-term trends.

Data Sensitivity Statement

Network staff must ensure that all references to protected information are removed or obscured in any reports, publications, maps, or other public forum. Following the standard for Freedom of Information Act (FOIA) requests, the Network will segregate the non-releasable information and where practical will not withhold associated releasable information. Metadata for that dataset and the IRMA citation must also be updated to reflect that the associated data is sensitive. Network staff

must ensure that all references to protected information are removed or obscured in any reports, publications, maps, or other public forum.

The project leader is responsible for maintaining the security of data released to any NPS dataset catalog and ensuring confidentiality agreements are in place before sharing data with any non-NPS entity.

Roles and Responsibilities

Project Leader

- Ensures that the Peregrine Falcon monitoring protocol and all of its standard operating procedures are current and up to date. If methods must be changed the project leader ensures that the standard operating procedures remain in sync with actual data management operations. Ensures data are collected, processed and integrated with the master database consistently and strictly according to the specifications and methods described in the standard operating procedures. Performs an annual closeout with the Network program manager and data manager.
- Certifies the Peregrine Falcon monitoring dataset for analysis and publication and assures that the peregrine monitoring standard operating procedures (SOPs) are current and up to date.
- Performs analytical procedures and reports on findings
- Arranges technicians and budgets for data management costs, such as data entry and processing.

Data Manager

- Provides for the security, longevity and accessibility of the Peregrine Falcon monitoring dataset.
- Maintains software and hardware for file backups and security, databases, custom and proprietary applications and GIS tools.
- Guides personnel in data processing techniques, metadata generation and product archives in NPS data stores and enterprise databases.
- The data manager is not responsible for data entry, processing, metadata generation or archiving data deliverables.

Quality Assurance

The Peregrine Falcon Vital Sign plans for high data quality assurance by proactively deploying a system of administrative procedures and technological safeguards including:

- Standard operating procedures designed to minimize the introduction of errors during data collection and processing.
- Field crew training.
- Standard database security and integrity functions and data integrity constraints (Frakes *et al.* 2015) to enforce compliance with the Vital Sign's logical data model.

- Application level data entry checks and business rule enforcement.
- Periodic data quality audits and reports.

Data Collection

Data Collection Overview

The Peregrine Falcon monitoring program creates and maintains specific data deliverables (Table 2). Raw data deliverable files are collected during surveys and processed for quality (Figure 4).

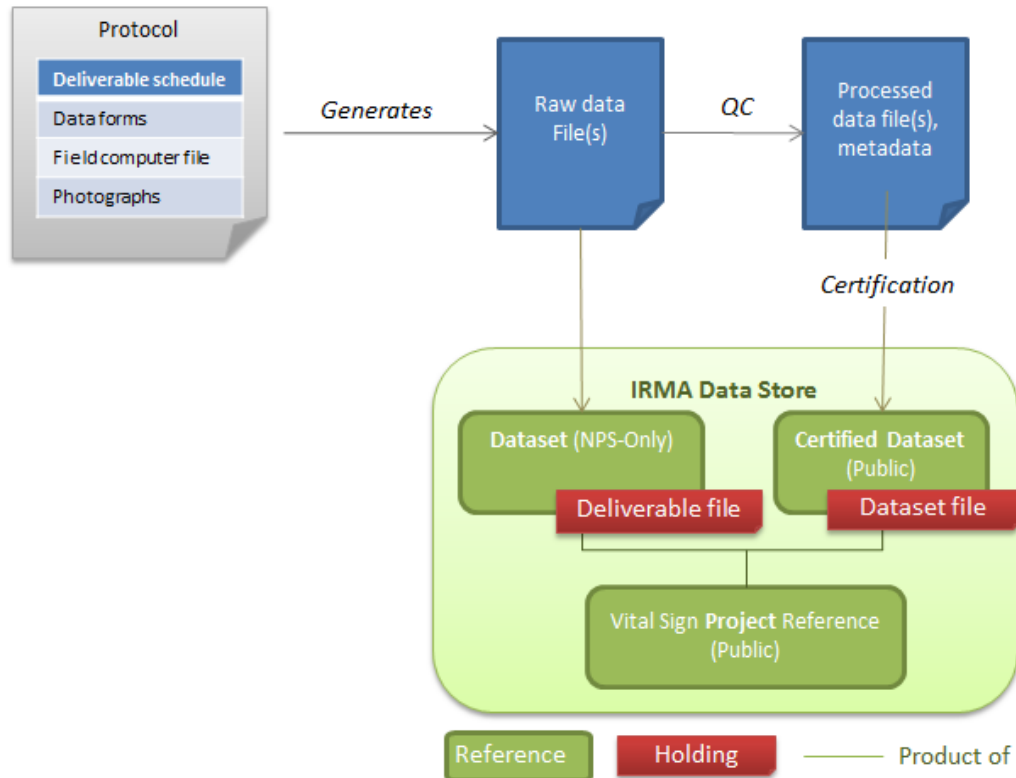


Figure 4. Data products processing and flow diagram. Data deliverables are collected on a cycle, processed to analytical quality, certified, and published to the IRMA Data Store. Raw deliverables are retained in private Dataset references.

During the survey, raptor observations are recorded on Rite-in-the-Rain Alaska Raptor Observation/Eyrie Cards (nest cards), survey and trip information are written in Rite-in-the-Rain field notebooks, territory and eyrie locations are recorded on topographic maps and on laminated bluff photos and eyrie drawing, waypoints and tracklogs are collected with GPS units, and photographs are taken of territory and eyrie locations and field work. Portable iPads with internal GPS units and loaded with a specialized NPS enterprise application, Park Observer, are used for navigation and marking waypoints of historic and new eyrie sites. A second Garmin 376C GPS unit also is used as a backup to mark waypoints and lay down a tracklog of the route. The Park Observer app has a background map of the upper Yukon River study area (.tkp) and data forms (.obsprots) into which to enter waypoints as the river is navigated. Waypoints from the iPads are backed up in the

field by emailing Park Observer files (to 'yugaipads2016@gmail.com'). Data in the field notebooks is backed up each evening by using the iPads to take photos of the nest cards, maps and field notes (should they be lost).

The CAKN_PEFA.accdb database contains spatial (territory and eyrie locations) and tabular (observations, samples) relevant to the survey and these data are verified against the hardcopy data in the data notebooks, nest cards, maps and photos and samples, and are edited as needed using Microsoft Excel. Data are exported to a temporary Excel file for exploration, verification, and validation for the QA/Q proofing process to certify data. Edits are updated to the CAKN_PEFA.accdb as needed. The CAKN_PEFA.accdb is spot checked for errors by the project manager and another technician. Once certified, the final CAKN_PEFA.accdb version containing all previous years' peregrine data is saved to the CAKN Network drive, and all other hard copy and digital data (photos, waypoints, tracklogs, nest cards, field notes, maps of territories, eyries drawings, sample collection data) are scanned and archived to the appropriate folders on the CAKN Network drive: For example: J:\Monitoring\PEFA\Scanned Field Notebooks and Databooks\2017 Scanned Field Data.

Once certified, field deliverables will be processed for quality and incorporated into a file based data management system on IRMA at this Peregrine Falcon Master IRMA Project reference: <https://irma.nps.gov/DataStore/Reference/Profile/2218300>.

The database is situated behind the NPS firewall and access is limited to NPS staff until data are proofed and of the quality required to be released to the public on IRMA. Database access, security and administration will be managed by the Network data managers. The local Peregrine Falcon monitoring database will be the working database used for assessing and improving data quality until such time that it is certified. At that time a certified copy will be attached to the I&M database server in Denver, CO and the dataset's reference in IRMA updated with metadata and access information.

Deliverables Schedule

The Peregrine Falcon monitoring program creates and maintains specific data deliverables for customers. Deliverables collected during Peregrine Falcon monitoring include: Access database, photos, waypoints, tracklogs, nest cards, field notes, maps of territories, eyries drawings, and sample collection data. Each deliverable is disseminated directly from the IRMA Data Store, the single authoritative source for Network products. In the event that a data product ever diverges from that in the IRMA Data Store, the latter version should be considered authoritative. Deliverable include temporary Microsoft Excel and permanent multi-year Access databases, photos, waypoints, tracklogs, nest cards, field notes, maps of territories, eyries drawings, and sample collection cards.

The Peregrine Falcon monitoring program will create and maintain the data products shown in Table 2.

Table 2. Peregrine Falcon monitoring data deliverables schedule.

Identifier	Deliverable	Format	Schedule	Responsibility	Description
SM01	Peregrine Falcon Survey databases: .xlsx (by year) and CAKN_PEFA.acdb (all years)	Tabular	Remeasurement + 1 year	PI*	Tabular Access database containing processed QA/QC-checked survey data, including Peregrine Falcon occupancy, productivity and location data. Data are verified and validated in an annual temporary Excel file. The Access database contains processed QA/QC checked survey data, including attributes of each capture record. Proofed data are appended to this database each year.
SM02	Peregrine Falcon Survey Park Observer iPad application files	.pov, .csv, .tpk files	Remeasurement + 1 year	PI	Folder containing raw iPad Park Observer Files prior to importing and proofing those data in Excel and entering them into Access. Files include: .pov files containing field-collected survey data; .csv files containing field-collected survey data, waypoints and tracklogs; and the .tpk file with the base map.
SM03	Peregrine Falcon Survey digital images(photos)	.jpg	Remeasurement + 1 year	PI	Digital images of Peregrine Falcon survey field work, falcons, bluffs and eyries.
SM04	Peregrine Falcon Survey data collection nest cards and field notes	Physical forms and .pdf scans	Remeasurement + 1 year	PI	Annotated annual nest cards with field collected survey data, maps, eyrie drawings, bluff and eyrie reference photos, field notes and sample cards collected during the peregrine survey

*PI = Principal Investigator, DM = Data Manager

Data Entry/Import

Field data collection involves surveys to collect the majority of the products in the deliverables schedule above. See SOPs 2, 3, 4, 5 and 7 for details on the types of data collected. Most data processing will occur after returning from the field because crews are camping for the duration of the field work. However, data backups of iPads and field notes, nest cards and maps will occur in the field at the end of each survey day. Observers will back up their iPad Park Observer data by emailing the data to “yugaipads2016@gmail.com” and will back up their hard copy nest cards, map and field notes by taking photos of them with the iPads.

After the field work is completed, the Park Observer data from the iPads (.poz, .csv, .tpk) are downloaded to iTunes or emailed and are organized into folders by number date, territory location number and observer initials (e.g. 07102016YUKO225MJF; Note: do not use ‘/’ in files names for Park Observer or files are not exportable). All Park Observer data files are copied and saved to a backup drive and onto the CAKN Network drive (J:\Monitoring\PEFA\Data\ParkObserverData\2017. Tracklogs and waypoints from the GPS are downloaded via MapSource, copied and saved to the CAKN Network drive (J:\Monitoring\PEFA\Data\GPS\2017. Nest card data are entered and appended to the project’s multi-year Microsoft Access database (CAKN_PEFA.accdb) containing all observation and location (waypoints) data for the peregrine surveys. A Microsoft Access Excel file is exported after data entry is completed to explore data. This temporary Excel file is used for verification and validation against hard copy data to correct errors. Data will be verified and

reconciled against hard copy peregrine nest cards, field notes, maps, sample tags, eyrie drawings and photographs. Any changes to the hard copy field data will be crossed out with a line and initialed and the new information written below. Data will be validated in Excel through various filtering and sorting. Data discrepancies between hard copy field data, photographs, Park Observer data or GPS waypoints will be reconciled or excluded from analysis. After the QA/QC process is completed, data are uploaded and appended to the multi-year Access database (CAKN_PEFA.accdb) where they are spot checked by the project manager and an additional technician prior to certification, archiving and analysis.

The project manager will assemble all data following the surveys and perform a final QA/QC process. He/she will check all original hard copy field data for legibility and completeness, or will delegate this to a technician who was not involved with the data collection. Any remaining discrepancies between the hard copy field data and the iPad Park Observer data will be discussed and corrected with the observer. Questionable entries are highlighted and discussed with data collectors and the program manager to reconcile discrepancies, when possible. The hard-copy field data will be scanned and saved into an annual .pdf following the final QA/QC, and the original Park Observer files (.pov and .csv) and photographs will be labeled and processed with standardized metadata for incorporation into the IRMA Data Store (see [Product Archival, Seasonal Closeout and Dataset Certification Procedures for the Arctic and Central Alaska Inventory and Monitoring Networks](#): ARCN/CAKN Data Management Standard Operating Procedure #1 (Miller 2017). All digital files should be transferred to the appropriate ARCN/CAKN network drives for permanent storage. For more details on Data Management, see SOP 7. For details on archiving data to the IRMA data store, see SOP 10.

Analysis occurs on certified data within the Access database CAKN_PEFA.accdb. The Access database is then queried and data are extracted into the file format used in R (v. 2.14.2, R Development Core Team 2012) and Systat (Systat Software, Point Richmond, CA) to analyze occupancy and productivity data to estimate territory occupancy, nest success and productivity and assess the breeding performance of peregrine falcons in YUCH.

Contaminants data are submitted to USFWS for analysis. Contract laboratories process samples for types and levels of contaminants exposures. Data are returned to USFWS for analysis.

Peregrine Falcon monitoring data are stored on the CAKN Network drive and in a master IRMA Data Store file base management system at:
<https://irma.nps.gov/DataStore/Reference/Profile/2218300>.

Quality Control

Ensuring high data quality is a high priority for the Peregrine Falcon Vital Sign. Quality control procedures focus on verifying data as well as identifying and correcting errors in final data products. Quality control safeguards include:

- Data verification and/or double data entry procedures
- Spot checking

- Automated programmatic range, domain or impossible value checking
- Graphical and visual exploratory data analysis
- Statistical error or outlier identification
- Data quality audits and reporting.
- Dataset certification

Product Archival and Documentation

Director's Order 11D states that all records of natural and cultural resources and their management are considered mission-critical records (necessary for fulfillment of the NPS mission) and must be permanently archived. Mission critical deliverables are considered to be archived when they are uploaded to the IRMA Data Store. With few exceptions IRMA is the only authoritative repository for mission critical I&M products.

Data archiving is done in concert with seasonal close out and data certification (ARCN/CAKN DMSOP-1, Miller 2017). All data are archived in the following ways:

- IRMA Data Store. Formats may include:
- Raw and processed data files described in this protocol's deliverables schedule.
- Human readable text file of all Peregrine Falcon monitoring databases. A SQL script is built that can recreate the entire database and all the data within it.
- Network file server

Peregrine Falcon monitoring program data are maintained in file based management system at the master IRMA Data Store: <https://irma.nps.gov/DataStore/Reference/Profile/2218300>.

Peregrine Falcon monitoring program data are maintained on a network file share in the Fairbanks Administrative Center (FAC) in Fairbanks, Alaska. The certified database content is backed up to off-site storage at the NPS Natural Resource Stewardship and Science Directorate (NRSS) in Denver, Colorado and a separate NPS facility in Fairbanks. The NRSS and FAC use enterprise-level business continuity processes to maintain data security. In the event of catastrophe at one site, the original data may be restored from the other.

IRMA Data Store

The NPS IRMA Data Store is the primary organizational repository and publication platform for information related to the Peregrine Falcon monitoring program. The Peregrine Falcon Vital Sign has a single master IRMA project reference (<https://irma.nps.gov/DataStore/Reference/Profile/2218300>) to which all products are related (Figure 5).

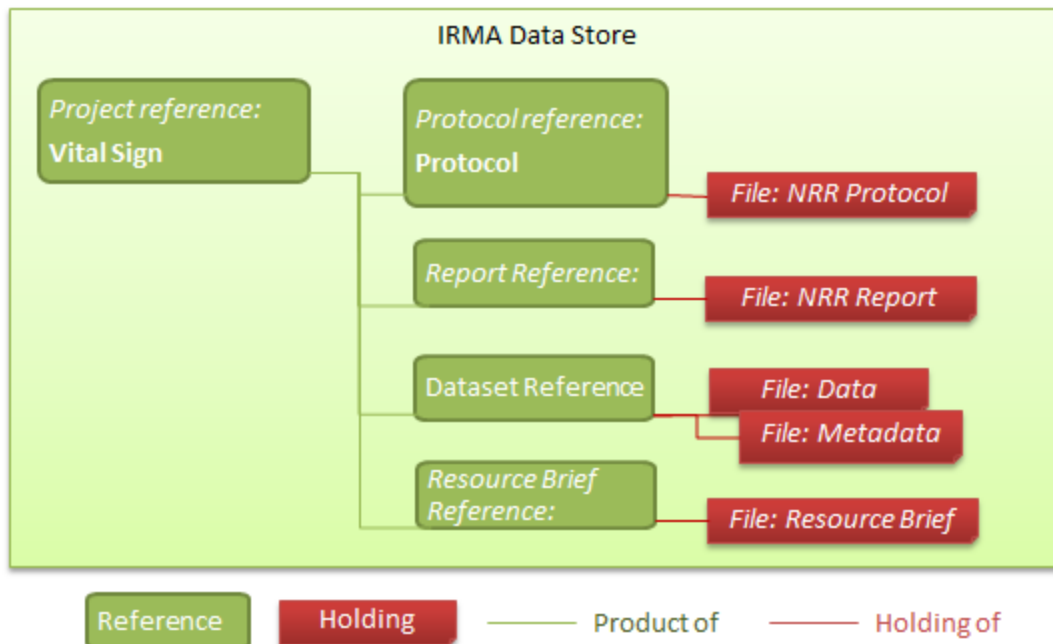


Figure 5. Standard ARCN/CAKN Vital Sign Project reference architecture in the IRMA Data Store.

The public Vital Sign web page covering Peregrine Falcon monitoring will publish the releasable contents of this reference and its related references via web services. It is the joint responsibility of the PI and the data manager to keep the system of related IRMA Data Store references up to date.

Reports

Reports will be published in the NPS Natural Resource Report publication series (<http://nature.nps.gov/publications/nrpm/index.cfm>) or professional journals. Reports and journal articles reporting analytical results will be published in tandem with the dataset that was used.

Natural Resource Reports are automatically tracked and announced to Network program managers and data managers but journal articles are not. The PI will create Data Store references for journal articles related to monitoring, link them to the Vital Sign's IRMA Project reference (Figure) and notify Network staff of their presence.

Certified Dataset

All reports providing statistical results will publish the data on which they were based. Metadata will be provided as well as a link to the certified original dataset (DO 11A, NPS 2005a). Data are made available through IRMA in machine readable formats according to Director's Order #11A (NPS 2005a) and as mandated by the Federal Open Data Initiative (Executive Order No. 13642).

The Peregrine Falcon Vital Sign will have a single public dataset reference in the IRMA Data Store to which certified data will be published (Figure). This reference will be the only authoritative data source available to the public: (<https://irma.nps.gov/DataStore/Reference/Profile/2218300>).

Resource Brief

The I&M resource brief is the primary outreach document for the Peregrine Falcon monitoring program. The principal investigator will revise any existing resource brief after new findings to reflect current understanding of the resource's trend and implications for park management. Resource briefs are made available on the Network web site through an IRMA Data Store Resource Brief product reference that is attached as a product of the main Vital Sign Project reference (Figure 5).

Products Publication

Reports, datasets and other monitoring products are published through NPS websites using the Vital Sign's master Data Store Project reference via web services exposed by the IRMA Data Store. Authoritative products will only be distributed through the IRMA Data Store (Figure).

Metadata

All project datasets, including spatial and non-spatial data, are archived in the IRMA data store with metadata (DO 11A, NPS 2005a, Figure). The mandate for adequate metadata comes from Director's Order #11A (NPS 2005a):

"All NPS data systems will develop data dictionaries and conform to available NPS organization-wide dictionaries. Geographic Information and Metadata must meet all Federal standards, DOI standards and NPS standards."

Preferred metadata formats include [Federal Geographic Data Committee](#) (FGDC 1998) and [Ecological Metadata Language](#) (KNB 2017).

Line of Sight

Line of Sight is the informal name given to the I&M program's philosophy that every datum should be inextricably linked in a traversable way to the standard operating procedure and protocol version that guided its collection (Figure 6). This custodial chain is maintained through metadata columns in the main monitoring database coupled with metadata maintained in each protocol and standard operating procedures' IRMA reference. A data consumer will be reliably able to access a data record and discover the standard operating procedure version that defined its collection and processing.



Figure 6. Each informational component informs and is informed by other components. Discovery of one component leads to discovery of all other components in a formalized data management chain of custody

Data and Information Security

Digital products produced by the Peregrine Falcon monitoring program will be stored in the IRMA Data Store in a file based management system, databases on I&M and/or local servers, and the Network file server in descending order of preference. Under no circumstances will any mission-critical information reside on individual I&M staff computers whether they are assigned to monitoring personnel by the NPS or not. Project materials will be secured and available on I&M servers at all times. The data manager, in conjunction with IT staff at FAC and with the Network support office in Ft. Collins, CO is responsible for backups, security and longevity of monitoring data.

Closeout

Closeout is the part of the Peregrine Falcon monitoring data management life cycle through which seasonal data collection files (deliverables, Table 2 and Appendix A) are archived in the IRMA Data Store (Figures 4 and 5). The Peregrine Falcon monitoring program will follow the procedures described in [‘Product Archival, Seasonal Closeout and Dataset Certification Procedures for the Arctic and Central Alaska Inventory and Monitoring Networks’](#): ARCN/CAKN Data Management Standard Operating Procedure #1” (Miller 2017).

Closeout happens after a re-measurement cycle when data files have been collected, processed and certified. Deliverables and the certified dataset are archived as holdings of private and public Dataset References in Data Store (Figure ; Figure ; Miller 2017). Closeout is complete when seasonal Dataset holdings reconcile with the deliverables schedule (Figure 7).

After closeout all permissions are removed from references except for the project leader and data manager. The references are then linked to the main Peregrine Falcon monitoring IRMA Project reference so that it becomes discoverable.

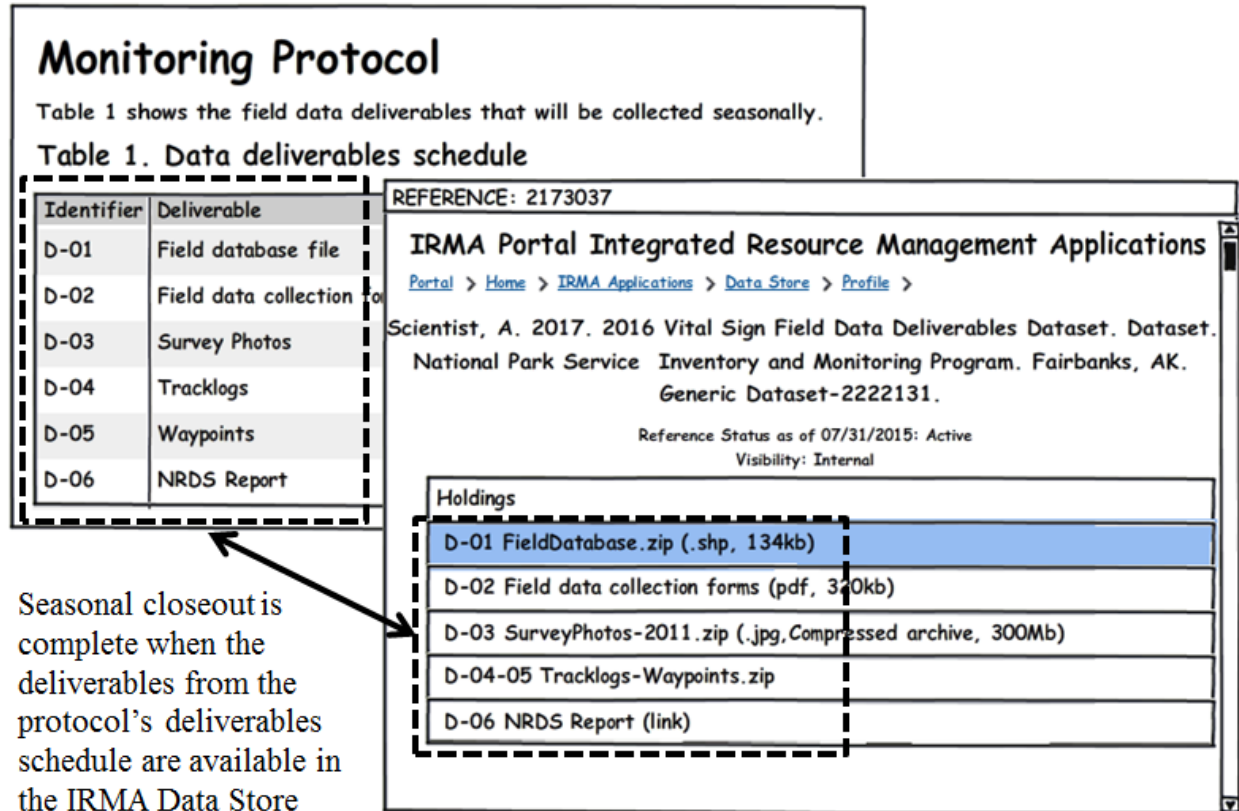


Figure 7. Data deliverables are defined in the monitoring protocol and archived in IRMA Dataset references after each re-measurement cycle. Closeout is complete when the holdings in the re-measurement Dataset reference match the deliverables in the protocol's data deliverables schedule.

The closeout method described above will ensure that all data objects collected during a re-measurement cycle are accounted for, documented and available for perpetuity should the need arise to re-use or revisit the data.

Certification

Certification is the phase of the Peregrine Falcon monitoring data management life cycle where the principal investigator formally confirms that the Vital Sign's dataset is ready for analysis (NPS 2016). Certification also affirms the scientific, administrative and technical integrity of the program including:

- The protocol and standard operating procedures are current. All technical changes are up to date and documented.
- Raw and intermediate data deliverables have been processed via quality control procedures, have been integrated with the vital sign's database or data management system and have been archived and documented appropriately for posterity.
- Each data record is traceable to the protocol version and SOP version that guided its collection.
- All closeout activities have been performed.

- The certified database or data files have been published to the Vital Sign's public Dataset reference in the IRMA Data Store.
- The Vital Sign's IRMA Data Store references and cross-links are complete.
- The dataset is of sufficient quality that analyses may be performed on it and the results

Certification will follow the procedures described in Miller (2017).

Analysis and Reporting

Analysis

Data analysis procedures of survey data are described in detail in SOP 8 and Ambrose *et al.* 2016. The occupancy and productivity data collected during the surveys will be used to estimate territory occupancy, nest success and productivity to assess the breeding performance of peregrine falcons in YUCH.

Reporting

Written reports will consist of: 1) survey summary reports, 2) administrative reports, 3) resource briefs, and 4) peer-reviewed articles in scientific journals or the NPS Natural Resources Technical Report series (NRTR). These reports may be written by the program manager and/or CAKN and park unit staff. Oral reporting may consist of presentations to the CAKN technical committee, subsistence committees, and presentations at scientific conferences. Detailed interpretation of estimates, including trend estimates, will occur at longer time intervals (e.g., after 3-4 surveys), and will be published as peer-reviewed articles or as NRTR reports. The target audience for these more comprehensive publications will be the scientific community. Such publications will document long-term trends or further methodological advances and will include maps, graphs, figures, and other visuals to facilitate comprehension of findings. All products will be made available on the IRMA Data Store (<https://irma.nps.gov/DataStore/Reference/Profile/2218300>).

Budget

The estimated annual cost (based on FY2016 dollars) of implementation of the Peregrine Falcon Monitoring Protocol is presented in Table 3. CAKN may have sampling performed by non-NPS personnel due to limited staff or availability and may have to increase costs to use partners (e.g. USFWS staff, volunteers, Student Conservation Association interns) when developing those contracts and agreements. Parks may provide support for monitoring, including staff participation in sampling, funding, logistical support and housing. This budget does not include support provided by parks or other partners, other than indicated savings on using GOVs for transportation, camping on site for the duration and using Volunteers in Parks (VIPs) for assistance in the field.

The YUGA Biologist (PI) provides project oversight. Field surveys are performed by one to two GS-11 permanent Biologists (YUGA/AKRO), two YUGA GS-04/05 biological technicians, or other youth interns including Volunteers in Parks (VIP), Student Conservation Association (SCA), Youth Conservation Corps (YCC) or students and/or partners from other agencies or organizations. The CAKN Biometrician formats and analyzes the data. Surveys occur annually for ~six weeks (three weeks for occupancy; three weeks for productivity). Data analysis and reporting take place each spring. Up to 75 territory locations are surveyed. The following budget is for one sampling year.

Table 3. Estimated annual operating cost (based on FY2016 dollars) for implementation of the CAKN Peregrine Falcon Monitoring Protocol.

Category	Detail	Costs (FY 2016)	Notes
Personnel	2x YUGA/AKRO Biologists	\$4,000	0.07 FTE GS-11-base salary in kind
	CAKN Biometrician	\$2,000	0.06 FTE GS-12- base salary in kind
	2x YUGA Biology technicians	\$4,000	0.21 FTE GS-05- base salary in kind
	2x YUGA SCA Interns	\$1,500	0.21 FTE GS-05 equivalent-salary in kind
	5-7x VIPs	\$0	0.21 FTE GS-03-05 equivalent-salary in kind
	Total Personnel Costs (annual)	\$11,500	(in kind, YUGA)
Equipment and Supplies	Field Supplies	\$2,000	Notebooks, maps, scope cleaning, parts
	Boat Maintenance	\$3,000	Welding ribs, winterizing, new parts
	Total Equipment Costs (annual)	\$5,000	—
Travel	Transportation and Lodging	\$3,000	AKRO Biologist flights/lodging Fairbanks
	Group Food (2 trips)	\$3,000	6 weeks, 4 people
	Total Travel Costs (annual)	\$6,000	—

Table 3 (continued). Estimated annual operating cost (based on FY2016 dollars) for implementation of the CAKN Peregrine Falcon Monitoring Protocol.

Category	Detail	Costs (FY 2016)	Notes
Contaminants	Laboratory Analysis	\$5,000	\$1,000/samplex5 samples
	Total Contaminants Costs (annual)	\$5,000	–
Total Protocol Implementation Cost (annual)	–	\$27,500	Estimated total implementation cost for each field-year (includes in kind)

Safety

Implementation of this protocol has multiple complex risks. Staff will continuously evaluate all risks at the programmatic, personnel, and site level. Programmatic-level safety information is presented here and procedures to mitigate risks associated with specific activities related to protocol implementation (such as safe operations of aircraft, vehicle use and operation, injury reporting and accident reporting) are addressed in standard operating procedures below.

Job Hazard Analyses (JHAs) were completed for all personnel who implement portions of the protocol in which risks and risk abatement strategies (including training needs) were identified. Risks and abatement strategies for all staff were synthesized to develop a protocol-level JHA. The protocol JHA was then used to perform a programmatic-level Green-Amber-Red (GAR) risk analysis to assess whether implementation of this protocol could be accomplished within an acceptable level of risk.

Specific safety concerns include:

- Crew members will spend many hours (and miles) motor boating, climbing, hiking and camping in remote areas over rugged terrain while sampling.
- Crew members may be working long hours.
- Crew members will frequently be exposed to inclement weather and will be working for extended periods of time in remote areas with potentially rapidly-changing weather conditions.
- Crew members will be exposed to hazardous wildlife (bears, moose, etc.).

Based on the JHA and associated risk abatement measures it was determined that this protocol can be safely implemented provided that CAKN and partner staff implement it in accordance with the referenced SOPs and recommended risk abatement strategies. In addition to SOPs that have been developed to safely implement this protocol, specific training needs for all staff have been identified including certification in basic and wilderness first aid, bear safety and remote communications. To increase the overall level of safety and awareness, obtaining additional levels of training beyond basic certifications will be encouraged.

Safety procedures will be routinely reviewed with Network staff and partners before field operations as prescribed in SOPs. Personnel-level JHAs for staff will be reviewed and revised annually as a part of the performance review cycle. Safety SOPs are reviewed at least annually and updated as necessary to ensure that they adequately mitigate risks to personnel, property, and the public.

In addition to protocol-specific safety procedures and guidelines, CAKN and partner staff will follow the general guidelines set forth in the NPS Occupational Safety and Health Program (Directors Order #50B, September 2008).

Standard Operating Procedures

To ensure consistent implementation of this protocol over time, the following Standard Operating Procedures (SOPs) were developed as needed for CAKN Peregrine Falcon monitoring (Table 4). To the greatest extent possible, SOPs are adopted from procedures approved and implemented programmatically through other monitoring efforts. All approved SOPs will be published in the NPS Natural Resource Report series and the latest approved versions of operational SOPs are always available for download at the NPS Integrated Resource Management Applications portal at <http://irma.nps.gov>. The SOPs will exist as separate stand-alone documents on the master IRMA data store in a file data management system: (<https://irma.nps.gov/DataStore/Reference/Profile/2218300>).

Table 4. Standard Operating Procedures required to implement the Peregrine Falcon Monitoring Protocol in CAKN (YUCH). Table lists SOPs by task category.

Subject	SOP	Citation	Notes	Link to Published Document / IRMA record
Before the Field Season	1	Ambrose, S., N. Guldager, S. Daw, M. Beer, Flamme, M. J., M. MacCluskie. 2018. Standard Operating Procedure (SOP) 1: Before the Field Season. Peregrine Monitoring Protocol for Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003)	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Training Observers	2	Ambrose, S., N. Guldager, S. Daw, M. Beer, Flamme, M. J., M. MacCluskie. 2018. Standard Operating Procedure (SOP) 2: Training Observers. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003)	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Using Global Positioning System (GPS) Units	3	Ambrose, S., N. Guldager, S. Daw, M. Beer, Flamme, M. J., M. MacCluskie. 2018. Standard Operating Procedure (SOP) 3: Using Global Positioning System (GPS) Units. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003)	https://irma.nps.gov/DataStore/Reference/Profile/2218300

Table 4 (continued). Standard Operating Procedures required to implement the Peregrine Falcon Monitoring Protocol in CAKN (YUCH). Table lists SOPs by task category.

Subject	SOP	Citation	Notes	Link to Published Document / IRMA record
Documenting Territory and Nest Location	4	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie. 2018. Standard Operating Procedure (SOP) 4: Documenting Territory and Nest Location. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003)	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Conducting the Peregrine Falcon Survey	5	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie. 2018. Standard Operating Procedure (SOP) 5: Conducting the Peregrine Falcon Survey. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003)	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Contaminant Monitoring	6	Matz, A., S. Ambrose, N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie. 2018. Standard Operating Procedure (SOP) 6: Contaminant Monitoring. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003), Ambrose <i>et al.</i> 2000	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Data Management	7	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie, J. H. Schmidt and S. D. Miller. 2018. Standard Operating Procedure (SOP) 7: Data Management. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003), Miller 2017, Ambrose <i>et al.</i> 2016	https://irma.nps.gov/DataStore/Reference/Profile/2218300

Table 4 (continued). Standard Operating Procedures required to implement the Peregrine Falcon Monitoring Protocol in CAKN (YUCH). Table lists SOPs by task category.

Subject	SOP	Citation	Notes	Link to Published Document / IRMA record
Analysis and Reporting	8	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie, J. H. Schmidt and S. D. Miller. 2018. Standard Operating Procedure (SOP) 8: Analysis and Reporting. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003), Miller 2017, Ambrose <i>et al.</i> 2016	https://irma.nps.gov/DataStore/Reference/Profile/2218300
After the Field Season	9	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie. 2018. Standard Operating Procedure (SOP) 9: After the Field Season. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Modified from <i>Alaska Peregrine Falcon Recovery Plan</i> (USFWS 1982), <i>Monitoring Plan for the American Peregrine Falcon</i> (USFWS 2003), Miller 2017	https://irma.nps.gov/DataStore/Reference/Profile/2218300
Revising the Protocol Narrative and SOPs	10	Ambrose, S., N. Guldager, S. Daw, M. Beer, M. J. Flamme, M. MacCluskie. 2018. Standard Operating Procedure (SOP) 10: Revising the Protocol Narrative and SOPs. Protocol for Monitoring Peregrines, Central Alaska (CAKN) Inventory and Monitoring Network. National Park Service, Fairbanks, Alaska.	Miller 2017	https://irma.nps.gov/DataStore/Reference/Profile/2218300

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Appendix A: Deliverables Schedule

Deliverable SM01 .xlsx (Microsoft Excel) and .accdb (Microsoft Access Database)

Deliverable SM01 includes a temporary annual Excel file and a permanent, multi-year Access database (CAKN_PEFA.accdb). The Excel file is a tabular database generated from Park Observer data files containing annual peregrine survey observation and location data. Data are explored, verified and validated against nest cards, field notes, maps, sample cards and eyrie drawing in the Excel file. The multi-year Access database is tabular and contains all data fields collected for each raptor observation (See SOP 2). The Access database contains processed QA/QC checked survey data, including attributes of each observation record. Proofed and certified data are appended to the Access database each year for archiving and analysis. Microsoft Excel (.xlsx) and Microsoft Access (.accdb) format. Full processing instructions are in SOPs 7 and 8. Schedule: Re-measurement mid-August + 1 year. Responsibility: PI

Deliverable SM02: iPad Park Observer application survey files (.pov, .csv)

Deliverable SM02 includes the iPad application layers exported from Park Observer. Location data are collected in Park Observer (waypoints, tracklogs, see SOPs 3 and 5), in the field. Park Observer survey files, base map, waypoints and tracklog files are emailed to the project manager during the survey. After the survey is completed, Park Observer files (“PEFA.pov” “Critter.csv,” “TrackLogs.csv,” and “GpsPoints.csv, “PEFA.tpk”) are downloaded and reimported to the Excel file for QA/QC, data verification, validation and are reconciled against field data notebooks Full processing instructions are in SOPs 8 and 9. Schedule: Re-measurement + 1 year. Responsibility: PI.

Deliverable SM03: Survey digital images (photographs):

Deliverable SM03 includes digital images, videos and photographs of field bluffs and eyries, falcons, field work, habitat, scenery, and wildlife collected during the peregrine survey. JPEG format (jpg). Preferably georeferenced. Full processing instructions are in SOP 7. Schedule: Re-measurement + 1 year. Responsibility: PI.

Deliverable SM04: Survey data collection forms and notebooks:

Deliverable SM04 includes scanned, annotated raptor nest cards, field notes, maps, laminated bluff and eyrie reference photos, eyrie drawings and sample card collected during the peregrine survey. Portable Document Format (.pdf). Physical files to be filed with PI and curated with regional curation. Full processing instructions are in SOP 2, 4, 5 and 7). Schedule: Re-measurement + 1 year. Responsibility: PI.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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